245/31

LDAA B6
STAA B7
A~~~ BB
SUBA B0
WAI   7E
JMP   3E
BEQ   27

NAME: _Kyle Ness_

University of Saskatch[...]
Department of Electrical Engineering
EE 331 – Microprocessor Hardware and Software
Mid-term Examination

Instructor: Seok-Bum Ko   October 27, 2003
Duration: 2 hours

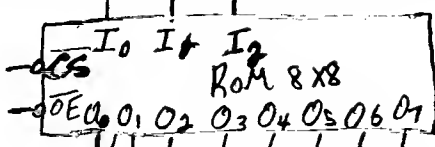- ***No materials are allowed.***

1. A particular microcomputer can store an 8-bit number in each memory location. If the memory addresses range from 0000_{16} to $FFFF_{16}$, how many memory locations are there? (1)

   64K ✓

2. __ts__ _(setup time)_ is the time interval immediately preceding the active transition of the CLK signal, during which the synchronous input has to be maintained at the proper level. (1)

3. Design a combinational circuit using a ROM. The circuit accepts a 3-bit number and generates an output binary number equal to the square of the input number. Provide the simple block diagram and ROM truth table. (2)

Assume
$O_0 = MSB$
$O_7 = LSB$
I_0 MSB
$I_2 = LSB$

-2

I_0	I_1	I_2	O_0	O_1	O_2	O_3	O_4	O_5	O_6	O_7
0	0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0	1
0	1	0	0	0	0	0	0	1	0	0
0	1	1	0	0	0	0	1	0	0	1
1	0	0	0	0	0	1	0	0	0	0
1	0	1	0	0	1	1	0	0	0	1
1	1	0	0	1	0	0	1	0	0	0
1	1	1	1	0	0	0	0	0	0	1

$\overline{CS}$ I_0 I_1 I_2
$\overline{OE}$ ROM 8×8
O_0 O_1 O_2 O_3 O_4 O_5 O_6 O_7

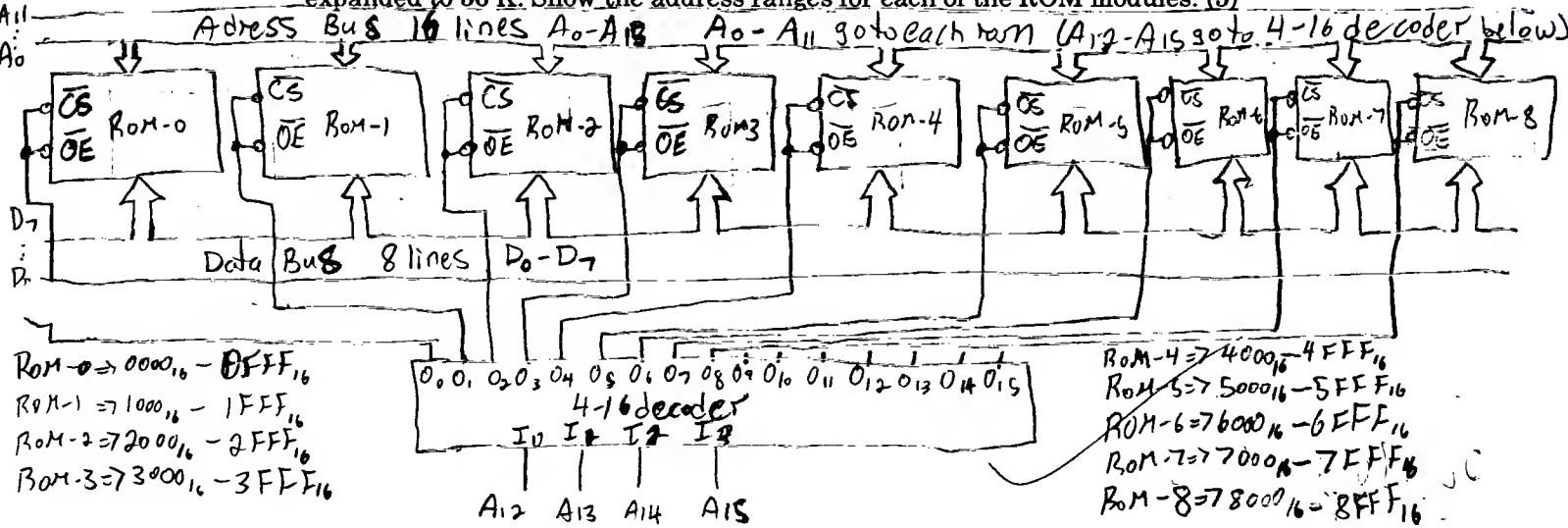4. Assume that initially [PC] = C877 and [A] = 09. Also assume that the content of memory location C457 is 03.

   (1) At the completion of this instruction, [pc] = _C87A_, [A] = _0C_, and [C457] = _03_ (3) ✓

   (2) Add an instruction to follow the instruction of Problem 4 so that the MPU stores the result in address C457. _STAA #C457_   _B7 C457_ (1)
       [PC] = _C87D_, [A] = _0C_, and [C457] = _0C_ (3)

Memory address	Memory word
C877	BB
C878	C4
C879	57

   C87A   B7
   C87B   C4
   C87C   57

5. Assume that we have a ROM of 4K × 8 size. Show how the ROM capacity can be expanded to 36 K. Show the address ranges for each of the ROM modules. (5)

   Address Bus 16 lines $A_0 - A_{15}$ $A_0 - A_{11}$ go to each rom ($A_{12} - A_{15}$ go to 4-16 decoder below)

   Data Bus 8 lines $D_0 - D_7$

   $O_0 O_1 O_2 O_3 O_4 O_5 O_6 O_7 O_8 O_9 O_{10} O_{11} O_{12} O_{13} O_{14} O_{15}$
   4-16 decoder
   $I_0 I_1 I_2 I_3$
   A_{12} A_{13} A_{14} A_{15}

   ROM-0 → $0000_{16} - 0FFF_{16}$
   ROM-1 → $1000_{16} - 1FFF_{16}$
   ROM-2 → $2000_{16} - 2FFF_{16}$
   ROM-3 → $3000_{16} - 3FFF_{16}$

   ROM-4 → $4000_{16} - 4FFF_{16}$
   ROM-5 → $5000_{16} - 5FFF_{16}$
   ROM-6 → $6000_{16} - 6FFF_{16}$
   ROM-7 → $7000_{16} - 7FFF_{16}$
   ROM-8 → $8000_{16} - 8FFF_{16}$

X A certain microcomputer allocates addresses 0000 to 7FFF to RAM, 8800 to 8FFF to I/O, and C800 to FFFF to ROM. (4)

(1) Draw the memory map for this microcomputer.

−1.5
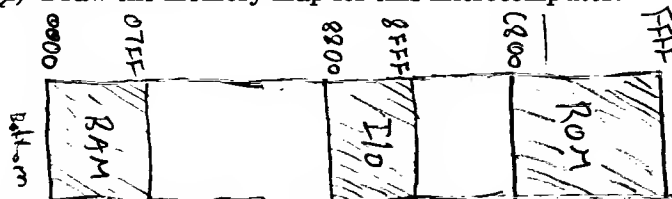
(2) Determine the total RAM capacity. How many "pages"? How many "4K pages"? _8 pages & 1/2 of a 4K page_ +

(3) Determine the total ROM capacity. How many "pages"? How many "4K pages"? _56 pages & 3 1/2 4K pages._ ✓

(4) How many different I/O devices can this microcomputer accommodate? _2K or 2048 devices._ ✓

X Consider the following program and assume that the stack pointer register is initially loaded with 6200_{16}. Show the contents of the stack after each instruction. What are the contents of the stack pointer register at the end of the execution? $61FD_{16}$ (3). Add the instructions so that the MPU pull all the contents off the stack.

PULB   PUL X   PULA (in that order since stack is LIFO) (1)

What are the contents of the stack pointer register at the end of the execution? _6200_{16}_ (3)

$$PSHA — 61FF_{16}$$
$$PSHX — 61FE_{16}$$
$$PSHB — 61FD_{16}$$

X The function of this program is to add two 8-bit numbers (X and Y) that are stored in memory locations C100 and C101, respectively. The sum is then stored in address C102. Provide the followings for this program. (4)
- Memory address (hex), memory word (hex), Mnemonic, and brief description.

Memory address	Memory Word	Mnemonic	brief description
C800	86	LDAA	loads [A] with value stored at memory location C100. (X)
C801	C1		
C802	00		
C803	BB	ADDA	Adds contents of memory location C101 (y) to the contents of [A] and puts result in [A] (X+Y)
C804	C1		
C805	01		
C806	B7	STAA	stores the contents of [A] (X+Y) in memory location C102. (X+Y)
C807	C1		
C808	02		

The END

$C100 = X$
$C101 = Y$
$C102 = X+Y$